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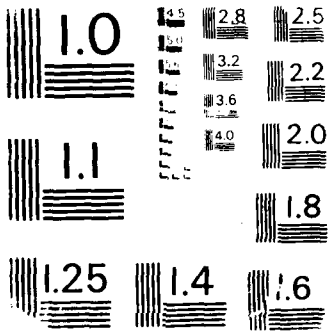
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FOREIGN TECHNOLOGY DIVISION

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by

Li Zhaomin, Liu Jing, et al.

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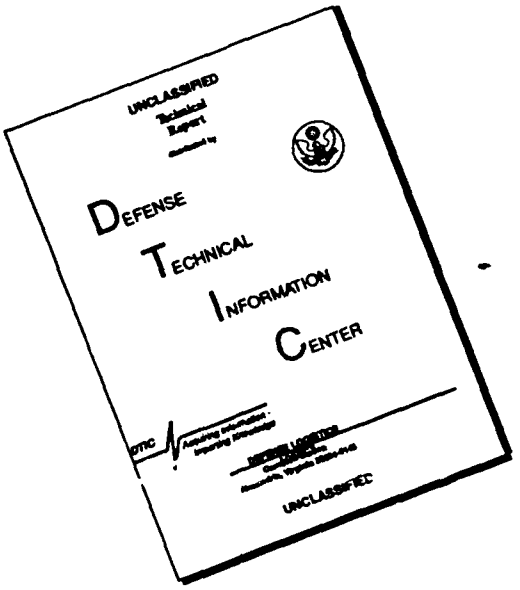

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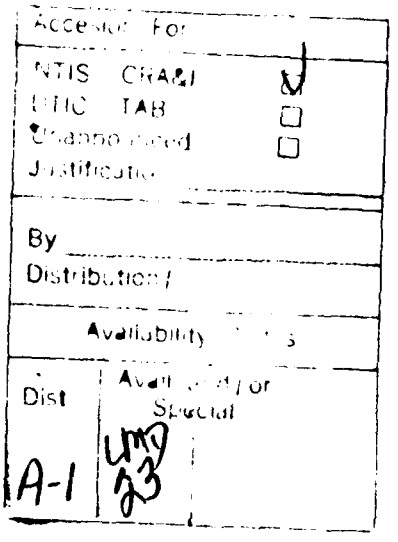

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A DATA ACQUISITION AND PROCESSING SYSTEM FOR SIX COMPONENT SOLID ROCKET MOTOR TESTING

Li Zhaomin, Liu Jing, Li Baojiang, Xu Zhuping

Summary: This article introduces the PDP-11/03 microcomputer for the collection and processing of data from six component tests of solid rocket motors. It discusses the components of this system, its capabilities and special characteristics. Finally, it gives measured values for the static precision of the system in test measurements.

FORWARD

Test platforms for the six component testing of solid rocket motors are principally used in measuring the thrust eccentricity produced in the operating processes of solid fuel rocket motors. During the period of motor operation, the size of the thrust eccentricity values and their direction change randomly. Generally, through the tests, measurements are carried out. However, the human processing of test data is both wasteful of labor and time and also prone to produce errors. In order to make the collection and processing of data from tests on the thrust eccentricity of solid rocket motors automated, we took the PDP-11/03 microcomputer and applied it to the measurement system for solid rocket motor six component tests, obtaining excellent results.

1. SYSTEM COMPONENTS

The solid rocket motor six component test measurement system is principally composed of the components below: the test bed or platform, sensors, strain gauges, amplifiers, A/D converters, computers, and other similar components. The schematic for the test measurment system is as shown in Fig. 1.1.

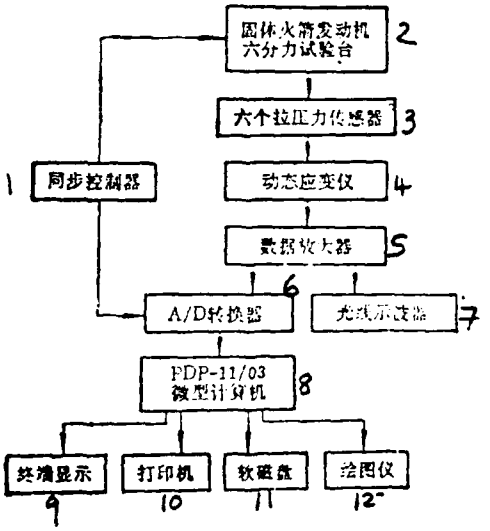

Fig. 1.1 Schematic diagram of the test system (1) Synchronous control devices (2) Solid rocket motor six component test platform (3) Six tensile and pressure sensors (4) Dynamic strain instrument (5) Data amplifier (6) A/D convertor (7) Optical oscilloscope (8) PDP-11/03 Micorcomputer (9) Terminal display (10) Printer (11) Soft magnetic disk (12) Graphics printer

2. SYSTEM FUNCTIONS AND CHARACTERISTICS

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This system's functions are principally to carry out the collection and processing of experimental data. All togetner, it has 5 programs: the six component force experiment standardization data collection program, the six component force experiment standardization data processing program, the six component force experiment data collection program, the six component force experiment data processing program, and the six component force experiment system check program. The main characteristics of these are as follows.

2.1 Data Collection

Standardization data and experimental data collection both make use of advanced mixing and program composition techniques. As far as PASCAL language and PDP-11 MACRO language mixing and program composition is concerned, it makes the advantage of the inexpensiveness of compiler language and the strong point of the representational power of the PASCAL language come together in an organic way. This type of method for the compiling of programs is, at the present time, the programing applied with the greatest efficiency to the compiling of programs in the software of data collection.

2.2 Data Processing

In the processsing of standardization data and experimental data, the high level FORTRAN language was selected for use in the composition of programs in both cases. In order to make the programs easy to read and easy to change, we took the standard commands and wrote commands to gather and arrange. When moving, we first connected the print port for the entry of the original print data. After that, we printed the computational results in layer order. Finally, we printed out characteristic curves for the changes over time of the thrust eccentricity distance.

2.3 System Checks

In the case of the six component force experimental system check programs, we also opted to use the PASCAL language and PDP-11 MACRO languages for mixing and program compilation. These programs were used in the checking of static system stability, zero point deviation values, diagnostic operations of A/D converters, as well as supervisory checks of the system. They were not only able to maintain the reliability of the system. They were also able to raise the precision of the experimental measurements.

3. MAIN ISSUES SETTLED THROUGH THE STUDIES ON THIS SYSTEM

The main issues which were settled through our studies on this system were: programming techniques, reliable A/D initiation, synchronous control, and other similar issues.

3.1 Reliable Initiation of A/D

In order to reliably initiate A/D converters, it is necessary to resolve two problems: checking to see if A/D converters are in normal operation or not before the experiments, and, during the tests, making the A/D converters initate or activate in a precisely specified way. In the case of the first problem, it was resolved through the systems check program. In the case of the second problem, we opted to use the "short circuit-constant voltage" method in order to solve it. It is only necessary for the synchronous initiator device to not activate or the ignition voltage to not match specification values. The A/D converter devices are all unable to activate. This also avoids accidental activation caused by interference signals from the outside.

3.2 Synchronous Control

The DT1761 model A/D converter's 0 path acts as the dedicated activation path. Before motor ignition, one needs to guarantee that the 0 path is in the "0" state. When the ignition signal is given, it is necessary to guarantee that the 0 path is in the "1" state (that is, the collection state). This system selects for use the synchronous circuit breaker method. It is able to reliably guarantee that the motor ignites and the A/D converters activate at the same time. Besides this, in the design of software, the synchronous control commands are also able to guarantee the synchronous activation of the A/D converters.

4. THE PRECISION OF TEST MEASUREMENT SYSTEMS

When carrying out measurements of static precision, one takes sensors, strain instruments, amplifiers, computers, and other similar devices and includes them all together as one set in order to comprehensively deal with the errors produced in the various individual links. As far as the static precision of axial thrust and

lateral thrust is concerned, they are measured separately. Each cycle of measurements is standardized as a whole 5 times. Each iteration of standardization chooses five levels of load increase and decrease. In the case of each single iteration of load increase and load decrease, the computer and oscilloscope measurement systems simultaneously carry out collection and recording. They separately calculate out non-linear errors, errors following overload, and repetitive errors. The results of measurements of static precision clearly show that the error for this system in the collection and processing of data from tests of six component forces is within 0.6%. However, the error for data processing by hand is approximately 1%. The precision of the computer system for collection and processing is higher than the precision of data processing by hand. The causes of this and measures taken are listed below.

(1) A/D converters take recursive check formulas and, throughout the process, carry out collection in sequence on the six component forces. The time interval between each of the sampling points selected was 1 ms (the sampling period was T = 0.001 s). The point count for each path in collection and processing, as compared to the point number selected for data to be processed by hand (generally selected as 20-30 points), is 30 fold greater or more. This raised the precision of all the average thrust eccentricity values measured.

(2) The checks program for the system to test the six component forces is capable of carrying out diagnosis on the test measurement systems and the A/D converters. If it discovers a problem, it is easy to investigate and analyze.

(3) The computer collection and processing system eliminated the manual measurement errors caused by data processed by hand and various types of human errors.

As far as the using of a system composed of the PDP-11/03 computer to gather and process data from tests on the six component forces in solid fuel rocket motors is concerned, the precision was high. The speed was fast. Each run from testing through collection to processing only required 5 min. As compared to the speed of processing data by hand, this was higher by 100 fold or more. We acheived the automation of the collection and processing of data on measurements of the thrust eccentricity of solid fuel rocket motors.

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